

June 1997

Preliminary Data Summary

by Field Research Facility

U.S. Army Corps of Engineers
Waterways Experiment Station
Coastal and Hydraulics Laboratory
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Preface

This report provides a summary of basic oceanographic, meteorological and bottom profile data for the month. The data were obtained as part of the Measurements and Analysis work units at the U.S. Army Corps of Engineers Waterways Experiment Station, Coastal and Hydraulics Laboratory (CHL), Field Research Facility (FRF) in Duck, North Carolina. The FRF staff collected and analyzed these data. These summaries are intended to make the data readily available to all FRF users, and comments on their content and usefulness are invited.

Data from these reports are now available via the World Wide Web at
<http://www.frf.usace.army.mil>

These web pages contain general information about the Field Research Facility and data from 1980 to the present.

Your comments and suggestions are welcome.

Introduction

1

The U.S. Army Corps of Engineers Waterways Experiment Station, Coastal and Hydraulics Laboratory (CHL), Field Research Facility (FRF) is located on the Outer Banks of North Carolina, near the village of Duck (Figure 1).

The FRF research program provides a means for obtaining high-quality field data, particularly during storms, in support of the U.S. Army Corps of Engineers' coastal engineering research missions. The research pier is a reinforced concrete structure supported on 0.9-m-diam steel piles spaced 12.2 m apart along the pier's length and 4.6 m apart across the width. The pier deck is 6.1 m wide and extends from behind the duneline to about the 6-m water depth contour at a height of 7.75 m above the National Geodetic Vertical Datum (NGVD) of the year 1929.

One of the responsibilities of the FRF research program is the collection, analysis and dissemination of data on local bathymetric, oceanographic, and meteorological conditions. This summary is intended to provide basic data as soon as possible after they are obtained. Questions and/or comments concerning the data may be directed to Mr. Clifford F. Baron at (919)261-6840 ext.222 (c.baron@cerc.wes.army.mil).

Chapter 2 presents the meteorological data; Chapters 3 through 6 present oceanographic data; Chapter 7 presents nearshore profiles and bathymetry; and Chapter 8, if included, documents special events that occurred at the FRF during the month.

Table 1 is a list of instruments used and their operational status during the month. Figure 2 shows weather and ocean conditions for the month. Table 2 and Figure 3 identifies the location of the instruments. The water depths at the wave gauges and current meters vary and may be determined from information contained in Figure 9. Other installation information is contained in Table 2.

Times given in the report are referenced to eastern standard time (EST).

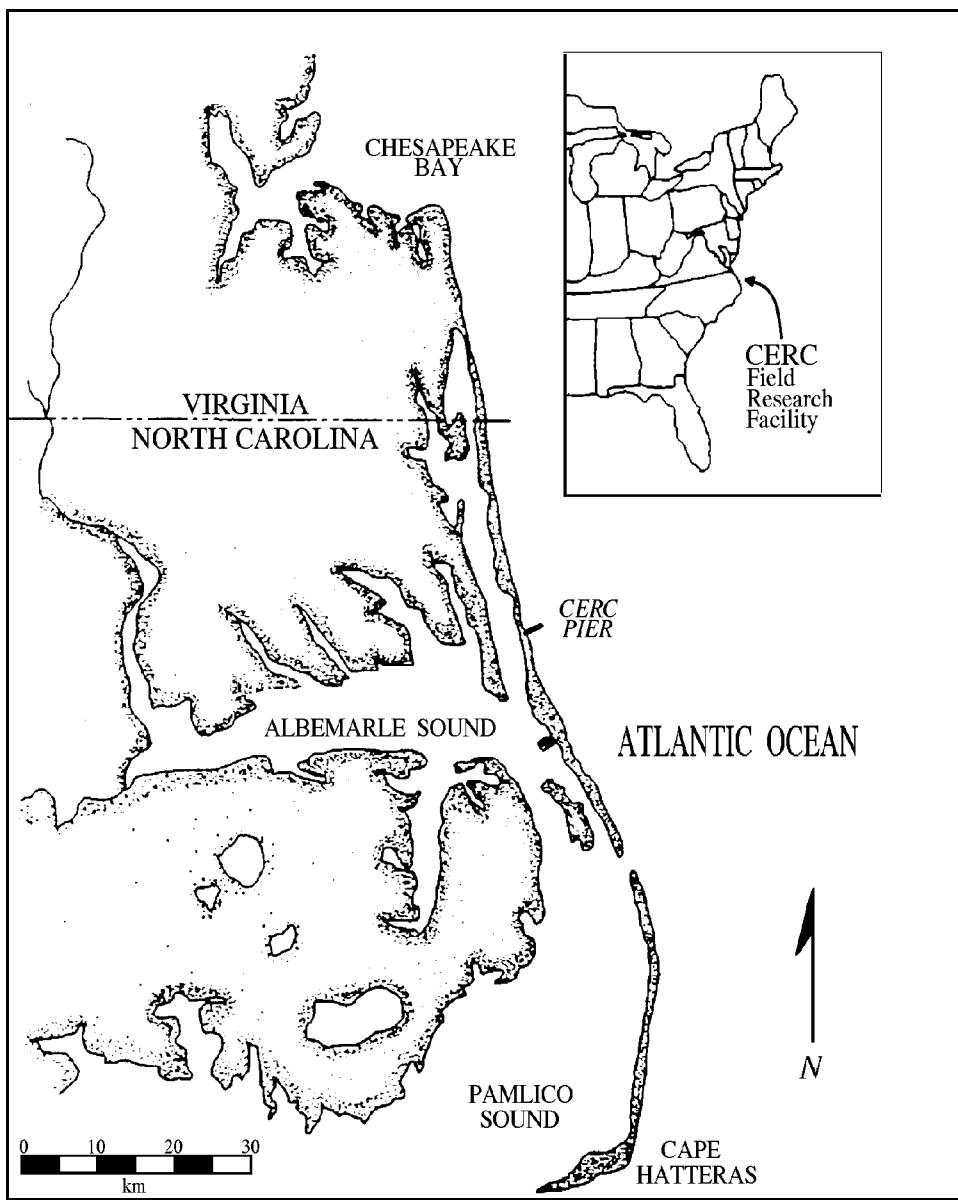


Figure 1. FRF Location Map

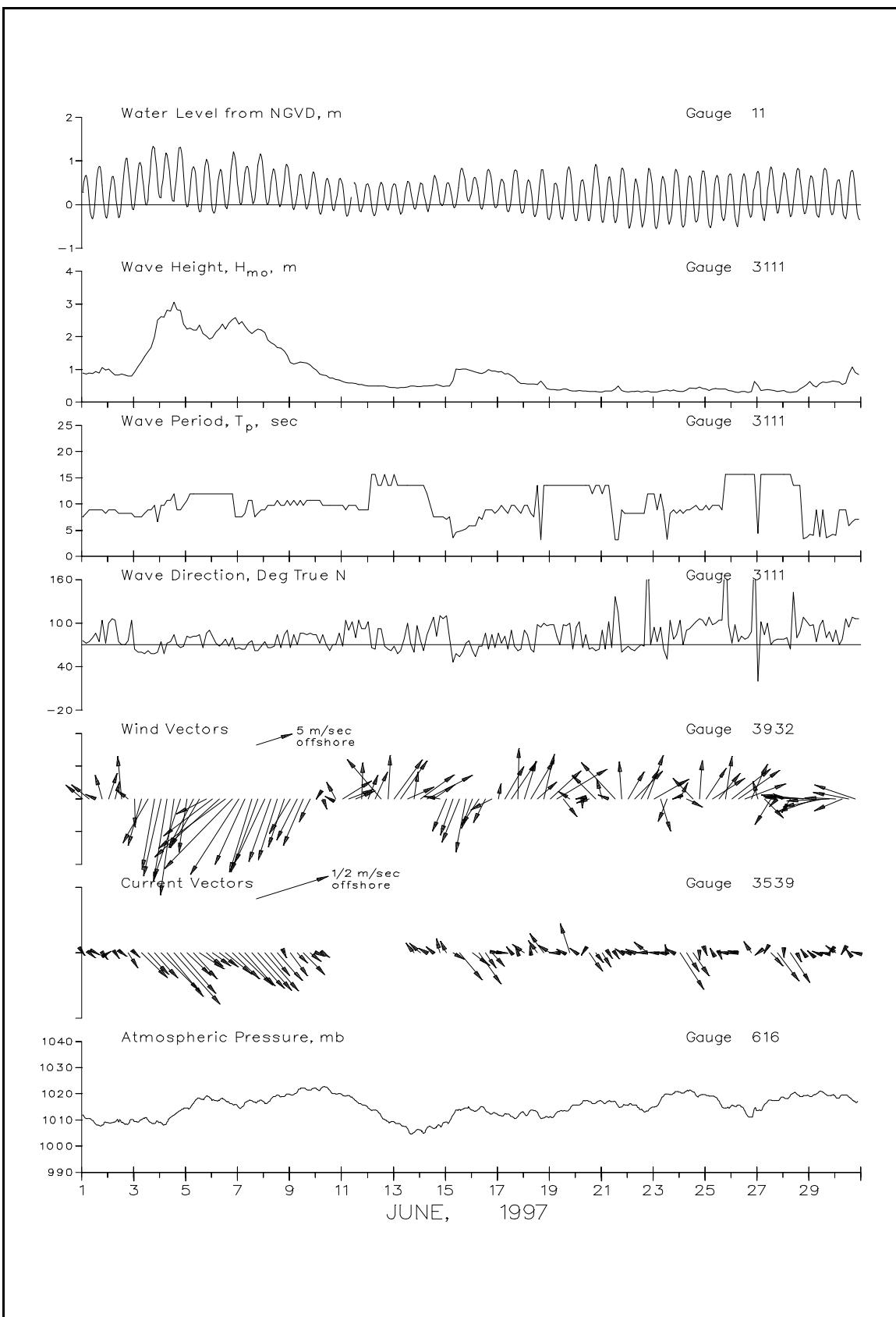


Figure 2. Month at a Glance

Table 1
Instrument Status/Data Availability

		June 1997																																
		Day of the month																																
Gauge	ID	Description/Remarks		1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	
		Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
616	Atmospheric Pressure	Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
604	Precipitation	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
624	Air Temperature	Gauge Status	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
3932	Anemometer	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
3932	Anemometer	Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
641	Pressure Gauge on FRF pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
625	Baylor staff on FRF pier	Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
3111	8 Meter Array 309 m north of FRF	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
3111	8 Meter Array 309 m north of FRF	Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
111	Pressure Gauge center of 8 Meter Array	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
630	Waverider buoy 4.0 km offshore	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/ / / /
3539	Current meter 343 m north of FRF pier (1.6 km offshore)	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
3539	Current meter 343 m north of FRF pier (1.6 km offshore)	Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
11	NOAA tide gauge at end of pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
11	NOAA tide gauge at end of pier	Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Visual Observations (daily oceanographic and meteorological observations)		Daily observation	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
Gauge Status		*	= Operational	/	= Partial	-	= Non-Operational																											
Data Collected		*	= All	/	= Partial	-	= None																											
Visual Observations		*	= Complete	/	= Partial	-	= None																											

Table 2
Gauge Locations

Gauge*	Description	*	Latitude	*	Longitude	*	FRF Coordinates	*	Gauge Depth	*	Water Depth
ID *		*	Degrees N	*	Degrees W	*	Crossshore	T	Longshore*	NGVD, m	* NGVD, m
616	* Atmospheric Pressure*	*	36 10' 57.03"	*	75 45' 5.50"	*	11.60	*	569.00	*	-----
3932	* Anemometer	*	36 11' 1.23"	*	75 44' 43.07"	*	585.20	*	517.30	*	19.50
641	* Pressure Gauge	*	36 10' 57.71"	*	75 44' 56.23"	*	239.11	*	516.64	*	-1.64
625	* Baylor Staff	*	36 11' 1.04"	*	75 44' 43.72"	*	568.00	*	516.64	*	Surface
3111	* 8 Meter Array North	*	36 11' 19.14"	*	75 44' 36.41"	*	915.23	*	990.16	*	-7.50
		*		*		*		*		*	*
	* 8 Meter Array South	*	36 11' 11.28"	*	75 44' 33.28"	*	914.20	*	735.37	*	-7.42
		*		*		*		*		*	*
	* 8 Meter Array East	*	36 11' 13.70"	*	75 44' 32.56"	*	954.51	*	800.58	*	-7.62
		*		*		*		*		*	*
	* 8 Meter Array West	*	36 11' 12.48"	*	75 44' 37.11"	*	834.66	*	800.37	*	-6.98
		*		*		*		*		*	*
111	* Pressure Gauge in center of 8 M Array	*	36 11' 14.06"	*	75 44' 34.39"	*	914.43	*	825.52	*	-7.76
		*		*		*		*		*	*
630	* Waverider Buoy	*	36 10' 5.10"	*	75 41' 59.30"	*	3934.96	*	-2400.81	*	Surface
		*		*		*		*		*	*
3539	* Current Meter	*	36 11' 23.57"	*	75 44' 9.12"	*	1605.80	*	907.60	*	-11.60
		*		*		*		*		*	*
11	* NOAA Tide Gauge	*	36 11' 1.25"	*	75 44' 42.60"	*	596.49	*	514.20	*	Surface
		*		*		*		*		*	*
	R	R	R	R	R	R	R	R	R	R	R

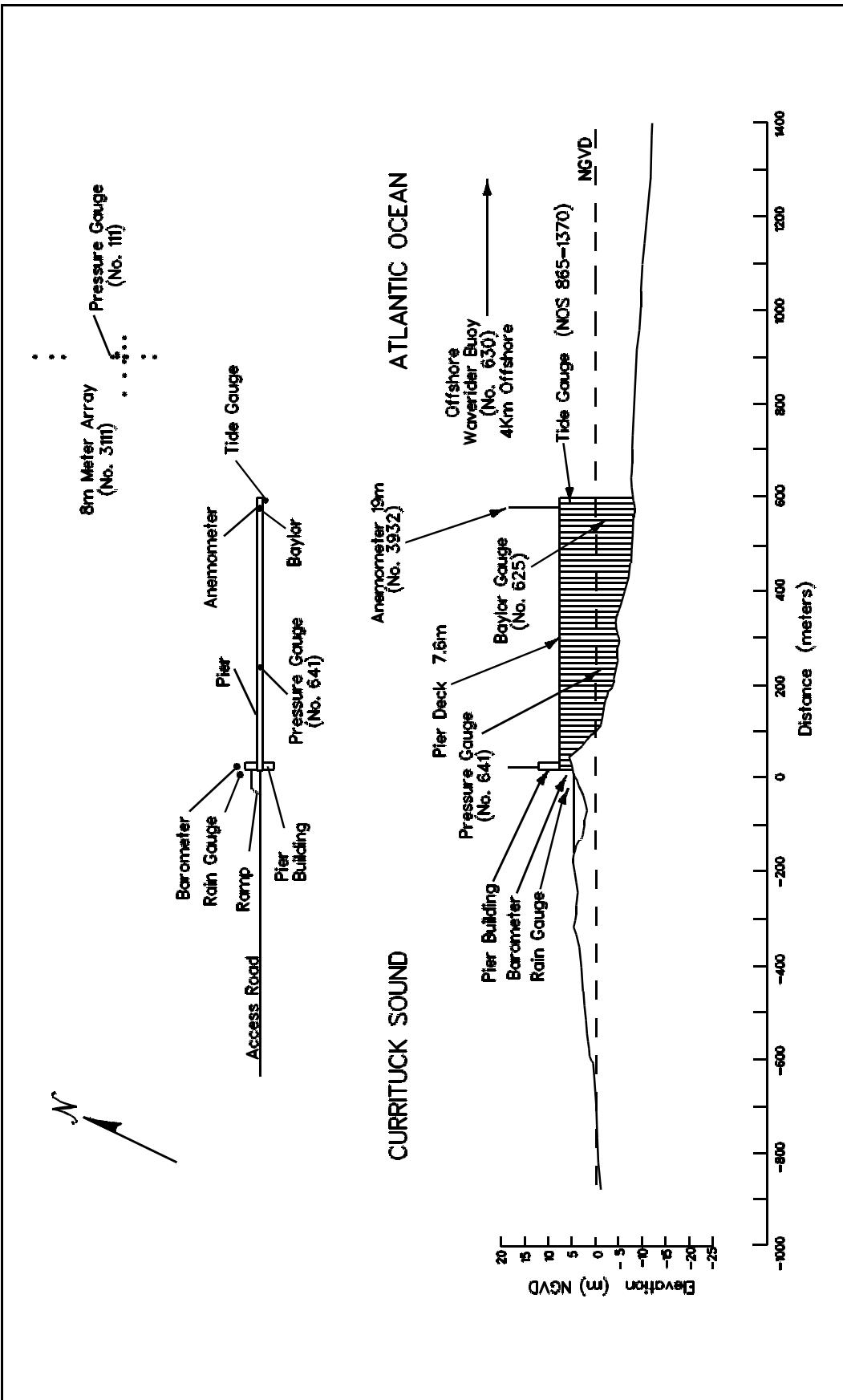


Figure 3. Instrument Locations, Elevations From NGVD

Meteorological Data

2

A variety of instruments have been installed at the FRF (Figure 3) to monitor the meteorological conditions. The data presented in Table 3 are collected and stored using a Digital Equipment Corporation VAXstation 4000. For each instrument identified in Table 1, a log is maintained and the records are stored for future reference.

Winds were measured at the end of the pier at an elevation of 19 m using a WeatherMeasure Skyvane anemometer. Monthly resultant wind speeds and directions (Figure 4) are determined by vector averaging the data. Wind directions (Table 3) indicate where the wind is coming from. Temperature and atmospheric pressure means (Table 3) are the average of the values presented for the month. Total precipitation is the sum for the month.

The following may be useful for converting the data in Table 3 to other frequently used units of measurement:

1. Millimeters (mm) to inches (in.) -
 $mm \times .03937 = in.$
2. Millibars (mb) to inches of mercury (in. Hg) -
 $mb \times 0.02953 = in. Hg$
3. Degrees Celsius (C) to degrees Fahrenheit (F) -
 $(C \times 9/5) + 32 = F$
4. Meters per second (m/s) to knots (kn) -
 $m/s \times 1.943 = kn$

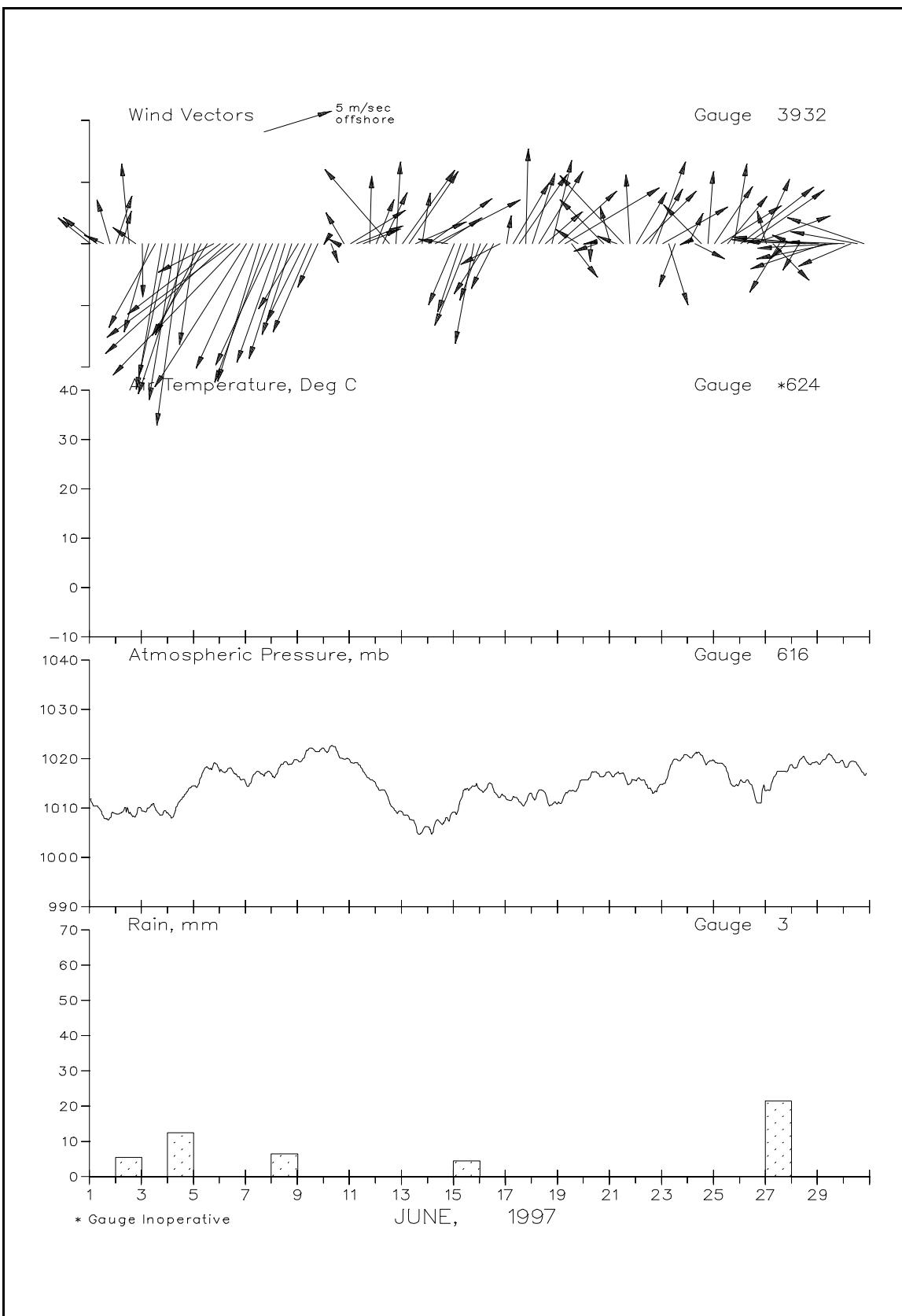


Figure 4. Meteorological Monthly Summary

Table 3
Meteorological Data

Jun 1997						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
1	100	3	132		1011.9	0
	700	3	132		1010.5	0
	1300	1	117		1008.4	0
	1900	4	165		1008.2	0
2	100	4	195	inoperative	1008.9	0
	700	3	192		1009.3	5
	1300	6	175		1009.0	0
	1900	2	129		1008.5	0
3	100	4	359		1009.4	0
	700	7	13		1010.1	0
	1300	7	25		1010.1	0
	1900	11	8		1008.7	0
4	100	12	10		1009.0	0
	700	13	8		1009.2	12
	1300	15	6		1011.8	0
	1900	13	15		1013.6	0
5	100	8	7		1014.6	0
	700	8	23		1016.3	0
	1300	8	1		1018.5	0
	1900	5	59		1019.2	0
6	100	9	1	inoperative	1017.7	0
	700	12	43		1017.5	0
	1300	12	49		1017.4	0
	1900	14	39		1016.1	0
7	100	13	28		1014.8	0
	700	11	21		1016.6	0
	1300	11	14		1017.4	0
	1900	12	17		1017.2	0
8	100	11	21		1016.4	0
	700	10	16		1018.1	7
	1300	10	15		1019.5	0
	1900	8	15		1019.0	0
9	100	6	27		1019.7	0
	700	7	23		1020.7	0
	1300	8	20		1022.2	0
	1900	4	21		1021.5	0
10	100	0		inoperative	1022.0	0
	700	2	341		1022.7	0
	1300	1	122		1021.5	0
	1900	3	153		1020.0	0

Table 3
Meteorological Data (continued)

Jun 1997						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
11	100	5	234	1019.4	0	
	700	3	245	1019.3	0	
	1300	3	244	1017.5	0	
	1900	5	181	1016.0	0	
12	100	4	198	inoperative	1014.5	0
	700	4	202		1013.8	0
	1300	8	143		1011.4	0
	1900	7	182		1009.5	0
13	100	7	211		1009.2	0
	700	7	210		1008.2	0
	1300	4	243		1006.7	0
	1900	4	188		1005.2	0
14	100	6	230		1006.2	0
	700	7	239		1007.0	0
	1300	3	1		1006.8	0
	1900	2	100		1007.9	0
15	100	5	20		1009.2	0
	700	6	16		1011.8	4
	1300	7	18		1014.0	0
	1900	8	9		1014.5	0
16	100	5	17	inoperative	1013.8	0
	700	5	29		1014.1	0
	1300	4	23		1013.9	0
	1900	3	58		1012.3	0
17	100	2	188		1011.9	0
	700	6	207		1012.4	0
	1300	7	210		1011.3	0
	1900	8	181		1011.3	0
18	100	6	195		1012.5	0
	700	7	207		1013.8	0
	1300	4	224		1013.0	0
	1900	7	191		1010.7	0
19	100	6	223		1011.3	0
	700	8	235		1012.8	0
	1300	3	326		1013.5	0
	1900	2	127		1014.2	0
20	100	0		inoperative	1015.8	0
	700	1	2		1017.0	0
	1300	2	69		1017.1	0
	1900	5	139		1016.5	0

Table 3
Meteorological Data (concluded)

Jun 1997						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
21	100	3	166		1017.1	0
	700	1	114		1017.2	0
	1300	7	141		1017.1	0
	1900	6	177		1015.0	0
22	100	5	206	inoperative	1015.6	0
	700	6	221		1015.7	0
	1300	5	207		1014.1	0
	1900	7	197		1013.4	0
23	100	5	236		1014.9	0
	700	5	345		1017.5	0
	1300	4	18		1020.0	0
	1900	0			1020.3	0
24	100	3	202		1020.6	0
	700	2	300		1021.1	0
	1300	4	139		1020.8	0
	1900	6	183		1019.3	0
25	100	5	209		1019.6	0
	700	5	233		1019.2	0
	1300	5	215		1017.3	0
	1900	7	187		1014.5	0
26	100	7	228	inoperative	1015.8	0
	700	7	231		1015.8	0
	1300	6	246		1013.5	0
	1900	6	201		1011.1	0
27	100	3	166		1013.6	0
	700	4	319		1015.9	21
	1300	4	27		1017.6	0
	1900	2	42		1017.5	0
28	100	2	117		1018.6	0
	700	2	27		1019.5	0
	1300	4	92		1019.9	0
	1900	6	95		1019.3	0
29	100	6	93		1019.0	0
	700	6	68		1020.0	0
	1300	5	76		1020.7	0
	1900	6	86		1019.3	0
30	100	4	92	inoperative	1018.8	0
	700	4	63		1019.5	0
	1300	5	102		1018.8	0
	1900	6	111		1017.0	0
		Resultant		Mean	Mean	Total
		1	52	inoperative	1015.0	49

Wave Data

3

Wave data are collected from three different sets of instruments, as shown in Table 1 and Figure 3. The first is an array of fifteen pressure gauges, collectively referred to as gauge 3111 (gauge 111 being one of them). Directional information is computed from these gauges using an iterative maximum likelihood estimator. The second is a Baylor staff gauge (625) and a pressure gauge (641), both attached to the pier. The third is a Waverider buoy (630). The data are collected, analyzed, and stored on optical disc using a Digital Equipment Corporation VAXstation 4000. Data is sampled at 2 hertz, with five contiguous 34 minute records, for a total collection period of nearly 2 hours and 51 minutes. This report reflects the data collection periods of 0100, 0700, 1300, and 1900 EST. The results are based only on the first 34 minute record. The exception is the 8 Meter Array (3111) which condenses the first four records into one statistical value.

Wave height H_{mo} is an energy-based statistic equal to four times the standard deviation of the sea surface elevations. Wave height reported from the pressure gauge has been compensated for hydrodynamic attenuation using linear wave theory. Wave period is identified from the computation of a variance (energy) spectrum with 60 degrees of freedom calculated from a 34-min record. Peak wave period T_p is defined as the period associated with the maximum energy in the spectrum.

Table 4 presents the wave heights and periods for each wave record obtained at 6 hr intervals during the month. The monthly means and standard deviations from the means shown in Table 4 are average values computed from this data. Figure 5 is a time history of all H_{mo} and T_p values obtained for all gauges.

Differences in wave periods between wave gauges (Table 4 and Figure 5) may be the result of wave breaking, wave reformation, the presence of multiple wave trains containing nearly equal energy, and statistical variations in spectral estimations.

Table 4
Wave Data

Jun 1997													
Day	Hour	641 Pressure Gauge			625 Baylor Gauge			3111 8 Meter Array			630 Waverider		
		Hmo,m	Tp,sec	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Dir,TN	Hmo,m	Tp,sec	Hmo,m	Tp,sec	
1	0100	0.34	8.6	0.82	7.6	0.89	7.6	76	0.96	7.7			
	0700	0.38	8.3	0.87	9.2	0.90	8.9	74	1.00	8.4			
	1300	0.39	8.6	0.82	8.9	0.94	8.9	86	1.11	9.1			
	1900	0.48	8.6	0.92	8.9	1.05	8.9	104	1.14	8.4			
2	0100	0.50	8.9	0.94	8.3	1.02	8.9	100	1.24	9.1			
	0700	0.43	8.6	0.79	8.3	0.83	8.9	104	1.10	9.1			
	1300	0.44	8.9	0.82	8.9	0.86	8.2	70	1.14	7.7			
	1900	0.45	8.3	0.70	8.6	0.80	8.2	76	0.89	7.7			
3	0100	0.52	7.4	0.83	8.1	0.93	7.6	64	0.95	7.7			
	0700	0.92	8.1	1.22	7.8	1.25	7.6	60	1.29	7.7			
	1300	1.07	8.6	1.42	8.3	1.55	8.9	62	1.87	9.1			
	1900	1.43	8.6	1.74	8.6	2.00	9.8	58	1.98	8.4			
4	0100	1.20	9.5	2.26	7.4	2.61	9.8	74	2.75	7.2			
	0700	1.53	10.7	2.45	10.3	2.82	10.8	72	2.86	10.6			
	1300	1.18	8.1	2.57	12.9	3.07	12.0	84	3.09	12.6			
	1900	1.67	12.9	2.46	12.2	2.80	8.9	66	3.06	11.2			
5	0100	1.06	10.7	1.95	12.2	2.24	10.8	82	2.44	10.1			
	0700	1.41	12.2	1.96	12.2	2.20	12.0	82	2.39	14.3			
	1300	1.15	13.5	2.02	12.9	2.36	12.0	84	2.47	13.4			
	1900	1.39	11.7	1.93	11.7	2.02	12.0	86	2.21	12.6			
6	0100	1.13	12.2	1.69	12.2	1.97	12.0	82	1.99	11.8			
	0700	1.36	12.9	1.94	12.2	2.25	12.0	68	2.31	12.6			
	1300	1.03	12.2	1.92	12.9	2.24	12.0	78	2.62	11.8			
	1900	1.48	11.7	2.29	11.7	2.53	12.0	80	2.37	6.7			
7	0100	1.19	11.7	2.28	7.0	2.39	7.6	66	2.75	7.2			
	0700	1.34	11.2	2.08	7.8	2.33	8.2	64	2.59	7.7			
	1300	1.10	11.7	1.92	11.7	2.10	10.8	76	2.32	7.2			
	1900	1.35	6.5	2.02	7.8	2.23	8.2	62	2.54	7.7			
8	0100	1.18	8.9	1.88	6.8	2.13	8.9	74	2.32	7.7			
	0700	1.08	9.5	1.61	10.3	1.83	9.8	66	2.00	10.1			
	1300	1.00	9.9	1.56	10.3	1.67	10.8	84	1.90	10.1			
	1900	0.83	10.3	1.41	9.9	1.57	9.8	84	1.75	9.1			
9	0100	0.75	10.7	1.22	10.3	1.21	9.8	66	1.30	9.1			
	0700	0.62	10.3	1.15	9.5	1.19	9.8	70	1.26	10.1			
	1300	0.70	10.3	1.23	10.3	1.22	9.8	86	1.32	10.6			
	1900	0.56	10.7	1.09	10.7	1.13	10.8	86	1.25	11.2			
10	0100	0.49	11.2	0.91	10.7	0.98	10.8	84	1.02	10.6			
	0700	0.33	9.5	0.77	8.3	0.83	9.8	84	0.87	10.1			
	1300	0.36	10.3	0.71	9.2	0.75	9.8	62	0.91	10.6			
	1900	0.32	9.5	0.62	10.3	0.70	9.8	70	0.77	10.1			

Table 4
Wave Data (continued)

Jun 1997											
Day	Hour	641 Pressure Gauge		625 Baylor Gauge		3111 8 Meter Array			630 Waverider		
		Hmo,m	Tp,sec	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Dir,TN	Hmo,m	Tp,sec	
11	0100	0.32	10.3	0.51	9.5	0.63	9.8	68	0.72	10.1	
	0700	0.24	8.9	0.44	10.3	0.59	9.8	90	0.64	10.6	
	1300	0.28	10.3	0.51	9.5	0.58	9.8	80	0.64	9.1	
	1900	0.25	9.2	0.41	9.5	0.55	8.9	92	0.58	10.1	
12	0100	0.26	8.9	0.41	9.9	0.50	8.9	102	0.57	15.4	
	0700	0.22	16.0	0.34	15.1	0.50	15.7	64	0.50	15.4	
	1300	0.31	15.1	0.43	14.3	0.49	13.6	92	0.59	15.4	
	1900	0.23	15.1	0.34	14.3	0.47	13.6	64	0.48	13.4	
13	0100	0.27	15.1	0.34	13.5	0.46	15.7	68	0.51	13.4	
	0700	0.19	14.3	0.29	13.5	0.45	13.6	62	0.46	14.3	
	1300	0.27	14.3	0.44	13.5	0.46	13.6	100	0.53	14.3	
	1900	0.26	13.5	0.39	12.9	0.49	13.6	60	0.56	12.6	
14	0100	0.29	13.5	0.42	13.5	0.47	13.6	76	0.65	13.4	
	0700	0.26	12.9	0.46	12.9	0.50	12.0	84	0.65	6.7	
	1300	0.31	8.3	0.47	8.1	0.52	7.6	108			
	1900	0.27	7.6	0.42	7.2	0.51	7.6	110			
15	0100	0.27	8.3	0.40	8.3	0.49	7.1	110			
	0700	0.44	3.8	0.74	3.9	0.67	3.5	46			
	1300	0.70	4.6	0.91	4.9	0.99	4.8	54	inoperative		
	1900	0.75	5.3	0.90	5.6	1.01	5.3	72			
16	0100	0.61	5.6	0.93	5.5	0.95	5.9	62			
	0700	0.49	5.7	0.84	6.0	0.90	7.6	68			
	1300	0.45	5.3	0.88	7.4	0.92	8.9	86	1.02	7.2	
	1900	0.47	9.2	0.96	8.9	0.95	8.9	84	1.01	8.4	
17	0100	0.37	10.3	0.92	9.2	0.93	8.9	86	0.99	9.1	
	0700	0.33	9.2	0.83	9.5	0.86	8.9	82	0.95	10.1	
	1300	0.35	9.9	0.76	7.6	0.82	9.8	90	0.95	7.7	
	1900	0.31	8.9	0.63	9.2	0.64	8.9	62	0.88	9.1	
18	0100	0.22	9.5	0.46	10.3	0.58	9.8	90	0.68	9.1	
	0700	0.25	14.3	0.45	8.6	0.56	8.2	64	0.66	10.6	
	1300	0.24	13.5	0.44	7.0	0.55	13.6	98	0.63	9.1	
	1900	0.27	14.3	0.46	13.5	0.55	13.6	100	0.68	13.4	
19	0100	0.17	14.3	0.29	7.4	0.39	13.6	98	0.50	9.1	
	0700	0.19	12.9	0.35	13.5	0.38	13.6	82	0.51	13.4	
	1300	0.17	13.5	0.31	13.5	0.40	13.6	98	0.48	12.6	
	1900	0.21	13.5	0.32	12.9	0.37	13.6	100	0.45	7.7	
20	0100	0.14	13.5	0.26	12.9	0.35	13.6	94	0.35	13.4	
	0700	0.18	12.9	0.32	12.9	0.34	13.6	66	0.41	12.6	
	1300	0.18	12.9	0.40	12.9	0.33	13.6	64	0.37	13.4	
	1900	0.22	12.9	0.40	13.5	0.32	13.6	62	0.36	12.6	

Table 4
Wave Data (concluded)

Jun 1997											
Day	Hour	641 Pressure Gauge		625 Baylor Gauge		3111 8 Meter Array			630 Waverider		
		Hmo,m	Tp,sec	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Dir,TN	Hmo,m	Tp,sec	
21	0100	0.14	14.3	0.34	13.5	0.31	12.0	90	0.38	11.8	
	0700	0.19	12.9	0.32	13.5	0.34	13.6	102	0.34	13.4	
	1300	0.16	11.7	0.39	2.6	0.40	3.2	136	0.47	8.4	
	1900	0.22	12.2	0.36	8.3	0.36	8.9	60	0.52	14.3	
22	0100	0.12	12.9	0.20	9.2	0.32	8.2	68	0.38	11.8	
	0700	0.18	13.5	0.27	8.1	0.33	8.2	62	0.39	8.4	
	1300	0.12	13.5	0.26	8.1	0.32	8.2	70	0.34	7.7	
	1900	0.19	12.2	0.28	12.9	0.34	12.0	210	0.43	13.4	
23	0100	0.13	13.5	0.26	12.9	0.31	12.0	94	0.37	13.4	
	0700	0.19	12.9	0.33	8.9	0.34	12.0	94	0.38	11.8	
	1300	0.23	3.4	0.38	3.4	0.37	3.3	50	0.53	3.2	
	1900	0.24	12.2	0.36	8.9	0.38	8.9	78	0.44	7.7	
24	0100	0.18	11.2	0.38	8.9	0.33	8.9	104	0.41	11.2	
	0700	0.20	8.9	0.36	8.9	0.38	8.9	90	0.42	8.4	
	1300	0.20	8.5	0.46	8.5	0.43	8.9	0	0.44	9.1	
	1900	0.23	8.9	0.46	8.9	0.47	8.9	106	0.63	8.4	
25	0100	0.21	9.2	0.40	9.2	0.40	9.8	96	0.49	9.1	
	0700	0.21	17.1	0.35	8.9	0.40	9.8	98	0.47	9.1	
	1300	0.24	8.9	0.38	9.2	0.40	9.8	104	0.49	8.4	
	1900	0.21	17.1	0.33	8.9	0.41	15.7	214	0.51	9.1	
26	0100	0.21	16.0	0.32	16.0	0.34	15.7	72	inoperative		
	0700	0.15	17.1	0.25	16.0	0.30	15.7	74	0.39	8.4	
	1300	0.20	16.0	0.29	16.0	0.32	15.7	78	0.39	9.1	
	1900	0.17	16.0	0.27	16.0	0.34	15.7	88	0.38	15.4	
27	0100	0.47	4.7	0.57	4.5	0.51	4.4	20	inoperative		
	0700	0.21	15.1	0.34	15.1	0.37	15.7	84	0.49	15.4	
	1300	0.26	15.1	0.38	15.1	0.38	15.7	70	0.53	3.4	
	1900	0.20	15.1	0.29	15.1	0.33	15.7	78	0.50	15.4	
28	0100	0.23	15.1	0.34	14.3	0.35	15.7	78	inoperative		
	0700	0.18	4.8	0.33	14.3	0.30	15.7	64	0.35	15.4	
	1300	0.23	15.1	0.36	9.9	0.32	13.6	80	0.42	14.3	
	1900	0.28	3.2	0.50	3.1	0.47	3.4	108	0.55	14.3	
29	0100	0.36	4.4	0.67	4.1	0.64	4.2	96	inoperative		
	0700	0.25	3.9	0.49	3.8	0.47	8.9	74	0.69	4.0	
	1300	0.34	3.9	0.62	4.5	0.62	8.9	104	0.76	4.2	
	1900	0.30	3.9	0.56	3.8	0.63	3.9	88	0.74	4.4	
30	0100	0.33	8.9	0.60	4.3	0.63	4.1	90	inoperative		
	0700	0.26	5.3	0.53	9.2	0.55	8.9	78	0.66	8.3	
	1300	0.40	5.0	0.67	5.3	0.86	5.9	94	0.84	5.1	
	1900	0.53	7.4	0.88	7.2	0.90	7.1	106	1.21	7.1	
Mean		0.48	10.6	0.81	9.9	0.89	10.2	82	1.03	10.2	
Std dev		0.39	3.4	0.61	3.2	0.69	3.1	24	0.76	2.9	

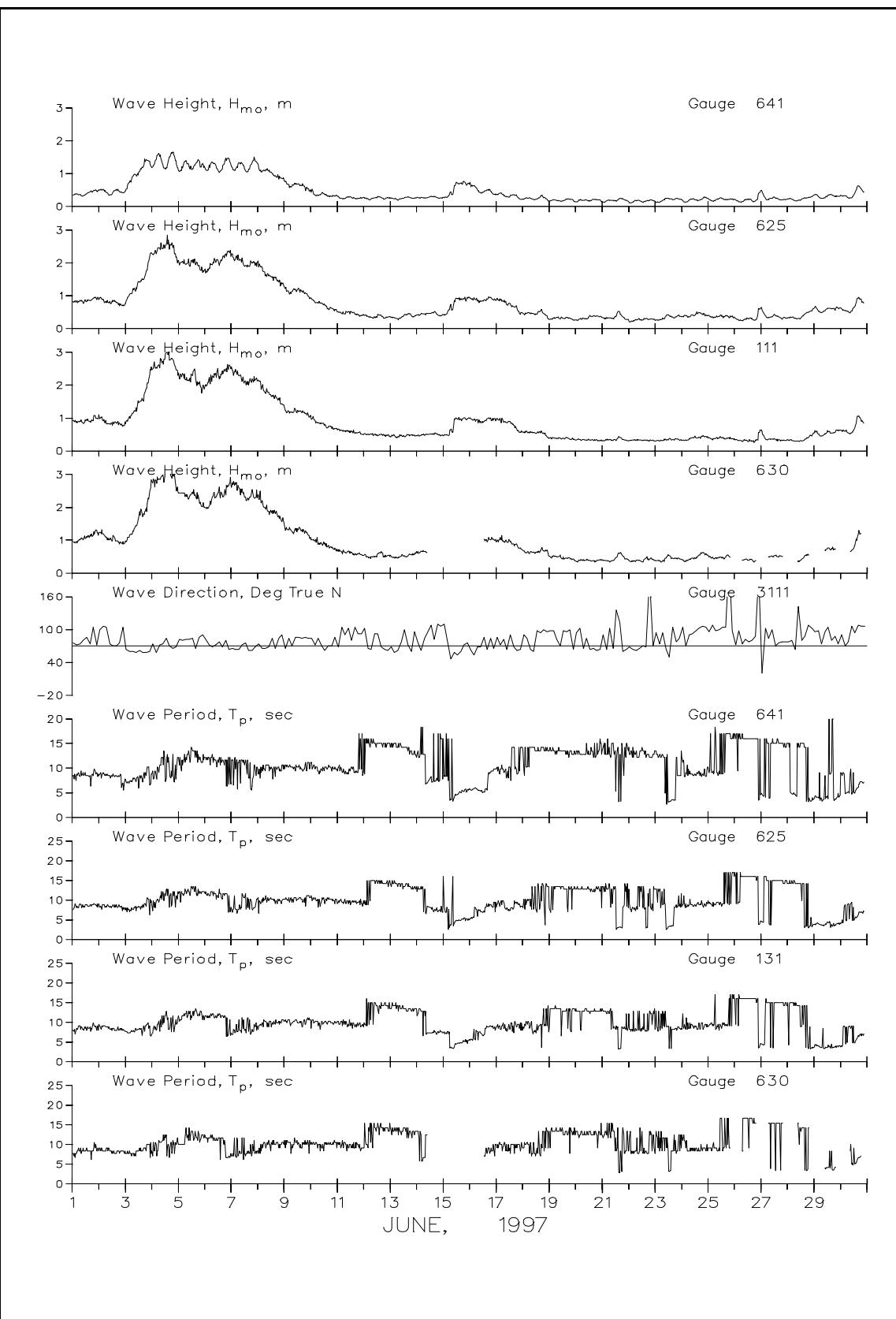


Figure 5. Wave Heights and Periods

Current Data

4

Current data (Table 5) are collected from a Marsh-McBirney electromagnetic biaxial current meter and by visually observing the movement of small drogues on the water surface in the surf and at the seaward end of the pier, as well as 500 m updrift of the pier, approximately 12 m offshore (Table 6).

Since the shoreline orientation is approximately N20W, longshore currents flow either toward 340 deg (i.e. northward) or toward 160 deg (i.e. southward). Similarly, cross-shore currents are either onshore (westward) or offshore (eastward). All current speeds are given in centimeters per second (cm/sec). Resultant speeds and directions are determined by vector averaging the cross-shore and longshore data. Current directions indicate the direction that the current is moving towards. Current data are plotted in Figure 2.

Table 5
Current Meter Data - Gauge 3539

JUNE 1997																	
	Cross	Long		Cross	Long		Cross	Long									
Day	Time	Shore	Shore	Speed	Dir	Day	Time	Shore	Shore	Speed	Dir	Day	Time	Shore	Shore		
1	100	0	2	2	150	11	100					21	100	-1	12	12	152
	700	-1	5	6	134		700						700	0	5	5	151
	1300	-1	2	3	120		1300						1300	0	5	5	150
	1900	-1	6	6	146		1900						1900	3	-3	5	306
2	100	-1	0	2	57	12	100		inoperative			22	100	4	-2	5	291
	700	0	5	5	148		700						700	5	-3	6	294
	1300	-1	4	4	131		1300						1300	3	0	3	268
	1900	-1	13	13	151		1900						1900	6	-10	12	313
3	100	-1	4	4	137	13	100					23	100	4	-1	4	278
	700	-9	24	26	138		700						700	3	-1	3	277
	1300	-6	20	21	140		1300						1300	0	-5	6	347
	1900	-7	23	24	141		1900	2	-8	9	325		1900	4	-4	6	303
4	100	-13	36	39	139	14	100	4	-8	10	315	24	100	-4	32	32	151
	700	-10	39	41	145		700	4	-4	7	304		700	-2	16	17	150
	1300	-14	47	50	142		1300	3	-5	7	314		1300	-3	20	20	149
	1900	-10	37	39	143		1900	-1	-10	11	348		1900	2	5	5	180
5	100	-8	22	23	137	15	100	1	-9	10	336	25	100	0	2	2	162
	700	-7	24	25	142		700	-4	7	9	124		700	0	-3	4	334
	1300	-10	17	20	127		1300	-6	24	25	144		1300	0	5	5	159
	1900	-6	14	15	133		1900		inoperative				1900	5	-2	5	279
6	100	-7	13	15	131	16	100	-6	13	15	130	26	100	3	0	3	265
	700	-7	14	16	131		700	-5	27	28	149		700	6	-3	7	284
	1300	-10	21	24	133		1300	-2	13	14	148		1300		inoperative		
	1900	-9	25	27	138		1900	-3	13	14	141		1900	2	-9	10	329
7	100	-12	31	33	138	17	100	-1	1	2	101	27	100	2	1	3	229
	700	-9	30	32	142		700	-1	1	2	95		700	0	0	0	
	1300	-10	33	35	142		1300	1	-4	5	325		1300	-3	12	13	141
	1900	-10	34	36	142		1900	0	-4	5	342		1900	-5	25	26	146
8	100	-10	35	36	143	18	100	5	-8	10	310	28	100	1	3	3	180
	700	-5	21	21	145		700	0	-4	5	354		700	-4	26	26	150
	1300	-7	25	26	143		1300	2	-10	11	328		1300	0	8	8	158
	1900	0	4	4	159		1900	4	-16	17	328		1900	1	-2	3	327
9	100	-4	21	21	148	19	100	6	-7	10	307	29	100	1	-1	2	316
	700	-3	10	10	138		700	4	-1	5	273		700	2	-1	3	294
	1300	-6	20	22	140		1300	3	-3	5	302		1300	2	0	2	284
	1900	-4	8	10	131		1900	-1	-22	23	344		1900	1	1	2	216
10	100	-3	4	6	117	20	100	3	-4	6	311	30	100	4	-6	9	310
	700	-2	5	5	128		700	2	1	2	209		700	1	1	1	208
	1300	inoperative					1300	-3	16	17	148		1300	1	-3	4	327
	1900						1900	-1	9	9	147		1900	2	-1	3	286

KEY:

+cross-shore = offshore, cm/sec
-cross-shore = onshore, cm/sec
+longshore = south, cm/sec
-longshore = north, cm/sec
Speed = Resultant speed, cm/sec
Dir = Resultant direction, degrees true north

Table 6
Visually Observed Current Data

Jun 1997												
Day	Pier End				Mid-Surf Zone				Beach			
	Cross Shore	Long Shore	Speed	Dir	Cross Shore	Long Shore	Speed	Dir	Location	Speed	Dir	
1	-15	38	41	182	-18	-61	64	323	South	20	N	
2	2	16	17	151	-10	-102	102	334	South	61	N	
3	-10	68	68	169	-12	41	42	177	North	23	S	
4	-9	61	62	169	-13	87	88	169	North	63	S	
5	-15	51	53	177	-10	17	20	191	North	25	S	
6	-16	41	44	182	-17	29	34	191	North	18	S	
7	-13	87	88	169	-18	61	64	177	North	38	S	
8	-8	76	77	166	-14	68	69	171	North	21	S	
9	-7	44	44	169	-17	55	58	177	North	27	S	
10	0	15	15	160	24	-41	47	11	North	14	N	
11	5	-8	9	11	17	-38	42	4	South	9	N	
12	7	-24	25	357	-10	-68	68	331	South	25	N	
13	13	-32	35	2	14	-47	49	357	South	18	N	
14	7	-12	14	11	-8	-51	51	331	South	17	N	
15	-10	68	68	169	-8	25	27	177	North	21	S	
16	-6	61	61	166	-10	23	25	184	North	32	N	
17	5	-12	13	4	18	-20	27	22	South	14	N	
18	10	-24	26	2	10	-32	33	357	South	27	S	
19	5	-11	12	4	11	-28	30	2	South	21	N	
20	5	11	12	136	1	-5	5	357	South	7	N	
21	-4	9	10	184	30	-41	51	17	South	23	N	
22	2	-23	23	346	13	-51	52	354	South	15	N	
23	0	3	3	151	5	-22	22	354	South	18	N	
24	6	38	39	151	7	-44	44	349	South	21	N	
25	4	-8	9	4	9	-61	62	349	South	9	N	
26	9	-15	17	11	32	-27	41	30	South	9	N	
27	-4	-23	24	331	13	-15	20	22	South	8	N	
28	-4	28	28	169	7	-22	23	357	South	4	N	
29	-14	-32	35	316	8	-25	27	357	South	16	N	
30	-4	-23	24	331	13	-44	45	357	South	21	N	

KEY:

- +cross-shore = offshore, cm/sec
- cross-shore = onshore, cm/sec
- +longshore = south, cm/sec
- longshore = north, cm/sec
- Speed = Resultant speed, cm/sec
- Dir = Resultant direction, degrees true north

Visual Observations

5

Visual wave direction measurements (Table 7) of both the primary wave train (i.e. that having the higher wave heights) and the secondary wave train (which must be clearly distinguishable as a wave train separate from the primary waves but not surface chop or capillary waves) are taken daily at the seaward end of the pier. The pier axis (considered perpendicular to the beach at the FRF) is oriented 70 deg east of true north; consequently, wave angles greater than 70 deg indicate that the waves were coming from the south side of the pier.

The width of the surf zone (seawardmost breaker position to shoreline) is determined from the pier deck.

Measurements of surface water temperature, density, and depth of visibility are also taken daily at the seaward end of the pier. A Bucket Thermometer is lowered about 0.3 m into the water and allowed to remain for at least one minute. The temperature is then read, and a hydrometer is used to determine the density. A Secchi disc is used to determine the depth of visibility.

Table 7
Visual Observations

Jun 1997

Day	Time	Wave Approach Angle at Pier End deg from True N		Width of Surf Zone,m	Water Characteristics at Pier End		
		Primary	Secondary		Temp.,C	Density g/cc	Secchi Vis.,m
1	0748	85		52	17.8	1.0200	2.4
2	0615	120		44	16.7	1.0216	2.1
3	0606	45		75	17.8	1.0209	2.4
4	0603	45		305	17.2	1.0200	0.9
5	0607	65		289	15.0	1.0216	1.5
6	0611	50		256	16.1	1.0220	1.5
7	0938	55		258	16.7	1.0200	0.9
8	0940	55		228	16.4	1.0200	1.2
9	0604	60		80	16.1	1.0217	0.9
10	0609	90		49	16.7	1.0200	1.8
11	0609	90		45	18.3	1.0200	2.1
12	0611	95		33	17.2	1.0210	1.5
13	0615	95		38	16.1	1.0244	1.5
14	1042	125		40	16.7	1.0242	1.5
15	0843	55		30	20.0	1.0190	1.8
16	0619	80		43	20.0	1.0174	1.5
17	0702	95		52	19.4	1.0210	1.8
18	0605	85		30	18.3	1.0234	1.5
19	0613	115		31	16.1	1.0244	1.5
20	0702	100		16	17.2	1.0238	2.4
21	1030	105		27	23.9	1.0190	2.7
22	1117	100		24	17.8	1.0238	3.0
23	0558	120		30	16.1	1.0242	3.4
24	0610	100		49	22.2	1.0108	2.7
25	0721	115		28	19.2	1.0230	2.1
26	0608	110		35	16.1	1.0240	2.1
27	0745	110		24	20.0	1.0230	3.0
28	1132	105		14	23.3	1.0190	2.4
29	0940	100		45	23.3	1.0188	2.7
30	0613	115		40	23.3	1.0200	2.7

Water Levels

6

Since 1978, the National Oceanic and Atmospheric Administration (NOAA)/National Ocean Service (NOS) has operated a primary tide station (No. 865-1370) at the seaward end of the FRF pier. A NOS acoustic tide gauge (Next Generation Water Level Measurement System, NGWLMS) is used to collect water level data every 6 minutes throughout the month.

The variation in water level during the month is shown in Figure 6 along with a list of means and extreme values. This presentation is useful in identifying effects of both meteorological and astronomical forces on the open coast water level.

Table 8 contains the range, high, low, and mean water level for each 12.42-hr tidal cycle.

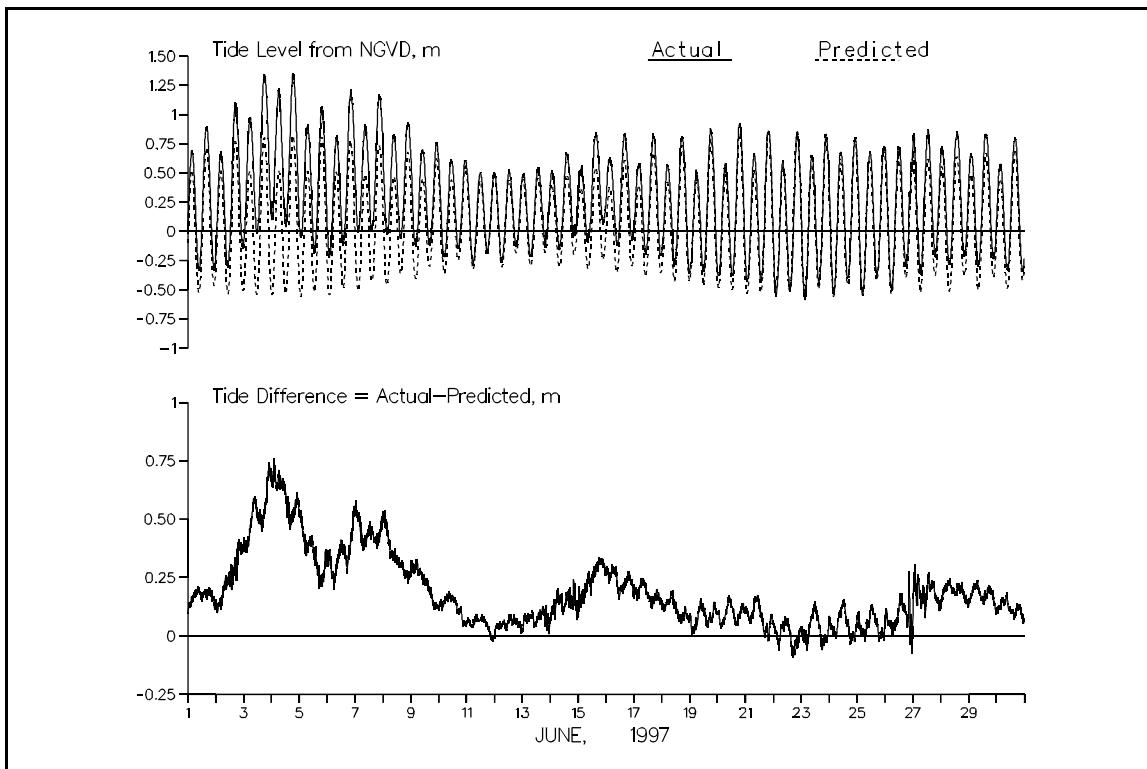


Figure 6. Water Level Variation

Table 8
Water Levels, m NGVD

JUN 1997 Tide Levels																		
Day	High			Low			Mean	Range	High			Low			Mean	Range		
	Time	m	Day	Time	m	Day			Time	m	Day	Time	m	Day				
1	0318	0.69	0	2354	0.00	0	0.45	0.69	16	0330	0.63	15	2142	0.05	0.36	0.58		
1	1606	0.90	1	0954	-0.34	1	0.28	1.23	16	1624	0.84	16	0954	-0.12	0.36	0.96		
2	0448	0.68	1	2248	-0.33	1	0.18	1.01	17	0442	0.58	16	2218	-0.08	0.26	0.66		
2	1706	1.10	2	1018	-0.31	2	0.39	1.41	17	1630	0.84	17	1018	-0.20	0.31	1.04		
3	0548	0.98	2	2336	-0.14	2	0.43	1.12	18	0430	0.57	17	2242	-0.21	0.18	0.78		
3	1748	1.35	3	1112	-0.02	3	0.68	1.37	18	1730	0.81	18	1030	-0.30	0.26	1.11		
4	0636	1.22	4	0030	0.10	4	0.67	1.13	19	0524	0.53	18	2342	-0.36	0.09	0.89		
4	1824	1.36	4	1236	0.04	4	0.70	1.32	19	1754	0.88	19	1124	-0.35	0.25	1.23		
5	0724	0.91	5	0130	-0.05	5	0.43	0.96	20	0654	0.58	20	0054	-0.38	0.10	0.97		
5	1918	1.07	5	1254	-0.19	5	0.44	1.26	20	1900	0.93	20	1242	-0.38	0.26	1.31		
6	0830	0.82	6	0154	-0.22	6	0.30	1.04	21	0748	0.67	21	0118	-0.43	0.12	1.10		
6	2006	1.21	6	1330	-0.13	6	0.54	1.34	21	1942	0.86	21	1318	-0.44	0.22	1.30		
7	0842	0.92	7	0248	-0.01	7	0.46	0.93	22	0812	0.61	22	0212	-0.55	0.03	1.16		
7	2054	1.17	7	1354	0.01	7	0.59	1.17	22	2012	0.84	22	1400	-0.52	0.16	1.36		
8	0930	0.83	8	0342	-0.03	8	0.40	0.86	23	0900	0.65	23	0312	-0.59	0.05	1.24		
8	2118	0.94	8	1530	-0.06	8	0.43	1.00	23	2118	0.83	23	1506	-0.47	0.18	1.29		
9	1012	0.70	9	0412	-0.13	9	0.29	0.83	24	0948	0.68	24	0354	-0.54	0.09	1.22		
9	2206	0.76	9	1618	-0.12	9	0.31	0.88	24	2242	0.81	24	1542	-0.41	0.19	1.22		
10	1054	0.61	10	0500	-0.22	10	0.20	0.84	25	1106	0.69	25	0436	-0.55	0.08	1.24		
10	2248	0.61	10	1642	-0.15	10	0.23	0.76	25	2336	0.73	25	1700	-0.37	0.18	1.11		
11	1130		11	536	No data this cycle				26	1142	0.73	26	0600	-0.50	0.13	1.23		
11	2330	0.50	11	1806	-0.16	11	0.17	0.67	27	0036	0.84	26	1806	-0.31	0.24	1.15		
12	1242	0.53	12	0548	-0.26	12	0.13	0.79	27	1312	0.87	27	0654	-0.37	0.26	1.24		
13	0106	0.50	12	1836	-0.14	12	0.19	0.64	28	0100	0.73	27	1930	-0.22	0.26	0.95		
13	1348	0.55	13	0700	-0.22	13	0.17	0.77	28	1412	0.86	28	0730	-0.29	0.29	1.14		
14	0130	0.52	13	1930	-0.14	13	0.21	0.66	29	0218	0.67	28	2030	-0.22	0.24	0.88		
14	1400	0.67	14	0754	-0.16	14	0.26	0.84	29	1512	0.84	29	0824	-0.30	0.28	1.13		
15	0248	0.56	14	1936	-0.05	14	0.25	0.61	30	0318	0.58	29	2106	-0.24	0.18	0.82		
15	1506	0.85	15	0824	-0.10	15	0.38	0.95	30	1606	0.80	30	0942	-0.34	0.23	1.14		

Bathymetry

7

A. Nearshore Profiles. In order to document profile response away from the pier, surveys of four profile lines extending 900 to 1,000 m from shore and located 489 and 581 m north and 517 and 608 m south of the FRF pier are conducted bi-weekly, after storms, and during more complete bathymetric surveys.

These profiles are obtained using a Trimble 4000 SSE GPS for positioning, in combination with the Coastal Research Amphibious Buggy (CRAB), a 10.7 m high, self-powered, mobile tripod on wheels.

Figure 7 shows the last survey in May and the survey(s) in June on profile line 188, located 517 m south of the pier.

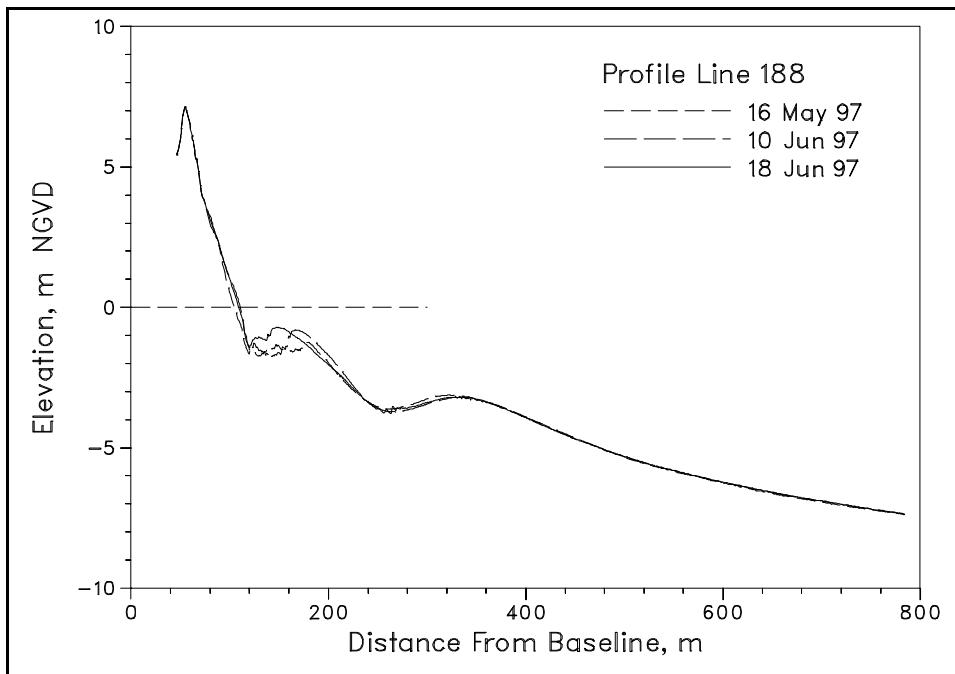


Figure 7. Monthly CRAB Profiles on Profile Line 188.

The profile envelope (Figure 8) reflects the maximum changes that occurred on the profile during 1997. Cross-hatched areas indicate changes to the annual envelope which occurred in June.

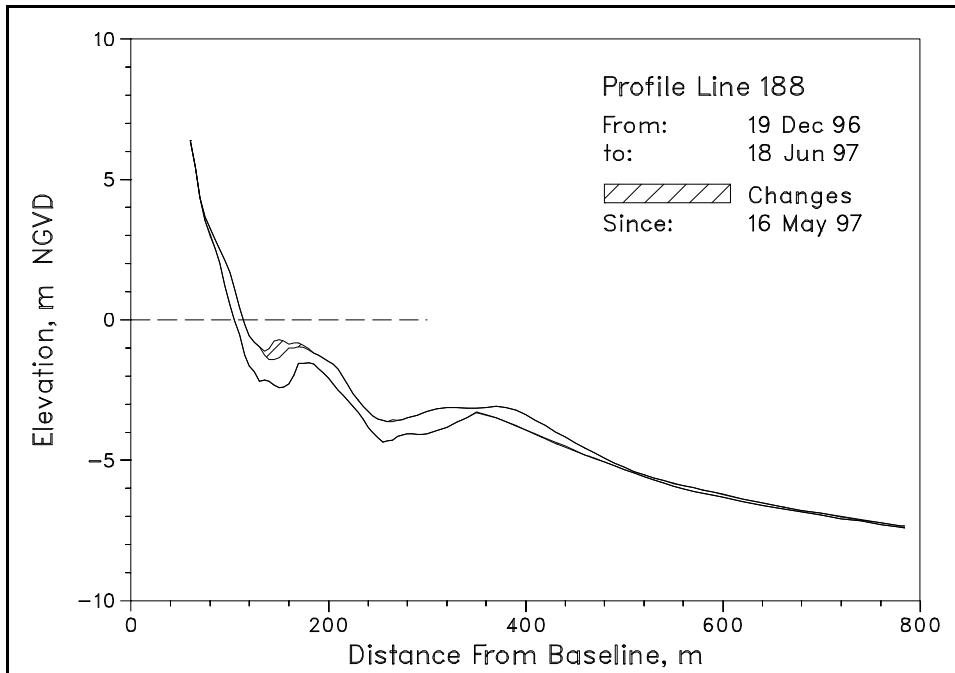
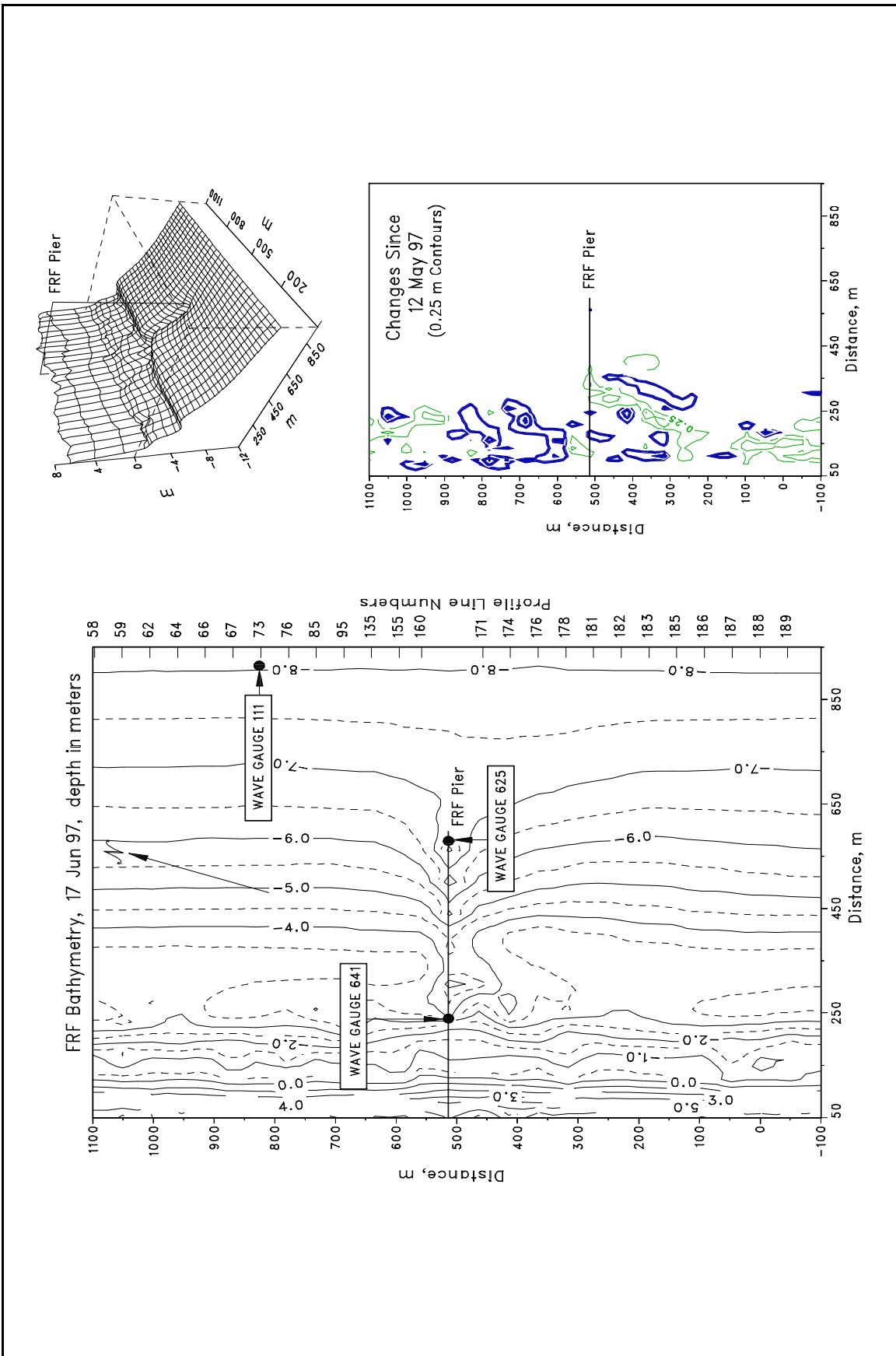


Figure 8. Profile Envelope - Profile Line 188.

B. Bathymetry. Figure 9 includes a two- and three-dimensional contour map and a change plot derived from the bathymetric survey on 17 June. Wide contour lines on the change diagram represent eroded areas; thin lines indicate deposition.



Special Events

8

A. Storm Data Collection. The following list identifies times when the wave height H_{mo} at the seaward end of the pier exceeded 2 m.

<u>Start</u>	<u>End</u>
3 Jun (2008)	7 Jun (2342)

B. Storm Synopsis.

Northeasterly winds were funneled between a Canadian high pressure system and a low pressure system that formed just offshore of the North Carolina - South Carolina border. Winds intensified as the low pressure system moved along the North Carolina coast and began moving out to sea by the morning of 4 June. Maximum onshore winds (NE) reached 15 m/s at 1142 EST on 4 June. The maximum H_{mo} , at gauge 625, reached 2.8 m ($T_p=11.1$ s) at 1334 EST on 4 June. There was 12 mm of precipitation.